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ABSTRACT

Several articles are presented covering the development and use of gas/electric cooling solutions for public schools and colleges. Articles address financing issues; indoor air quality (IAQ) problems and solutions; and the analysis of heating, ventilation, and air conditioning systems. Three examples of how schools solved their cooling problems are included, as are technology advances in gas cooling, and legislative issues. Concluding articles provide resources for school IAQ, discuss gas cooling as a solution to power crises, and presents a progress report on the University of Maryland's research of an advanced air conditioning system designed to cut carbon dioxide emissions by 45 percent and achieve 30 percent higher energy efficiency. (GR)

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Natural Gas Cool Times

Volume 11, Number 5

September/October 2000

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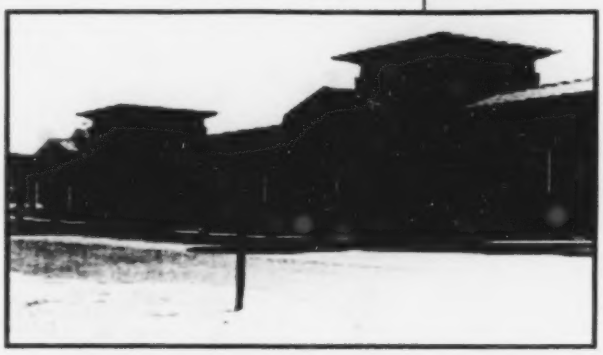
Natural Gas
COOL
TIMES
News Digest of the American Gas Cooling Center Inc.
SEPT/OCT 2000

Schools Seek Creative Financing For Infrastructure Improvements

Schools in the United States are looking for innovative ways to pay for much-needed improvements to their deteriorating facilities. Among the issues to be resolved is indoor air quality.

"The average school in this country is 42 years old," says John Lyons, an educational facilities program manager with the U.S. Department of Education in Washington, D.C. "When a school gets to 40 years, you're beyond the useful life of equipment, and it becomes problematic." Lyons says a 1995 report by the U.S. General Accounting Office "indicated there were a lot of very bad conditions in a variety of schools. Indoor air quality was one of them."

Bill Brenner, executive director of the National Clearinghouse for Education Facilities, also in the nation's capital, says air quality inside buildings has become a hot topic among architects, planners and school officials. "In the last few years, there's been a whole lot written about it," Brenner says. "Generally they know what to do; it's a question of getting the resources to do it."



Pupils and staff in a new building at St. Anne's School in Columbus, Ga., are breathing cool, dry air through a Munters gas desiccant system.

Funding Approaches on the Horizon

Several states are experimenting with different approaches to pay for upgrading schools, and there may be federal assistance on the way.

■ **In Ohio,** a portion of the state's settlement money from tobacco companies will be used to help finance a $23 billion, 12-year effort to rebuild schools, which were ranked 48th in the nation in a federal survey of the condition of school building facilities.

"Gov. Bob Taft is proposing a $23 billion program of state and local funding that would address all facilities needs of all school districts over the next 12 years," says Rick Savers, a legislative liaison with the Ohio School Facilities Commission. He indicates that a quarter of the state's $10.2 billion share will come from tobacco settlement funds, with the remaining $13 billion coming from local funding.

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Middle School Controls Humidity, Meets ASHRAE IAQ Requirements

Students and staff in a new middle school wing at St. Anne's School in humid Columbus, Ga., are breathing cool, clean, dry air thanks to a Munters natural gas desiccant dehumidification system installed last year.

The desiccant system serves a new one-story building that contains classrooms, computer rooms, a science laboratory, and a media center at St. Anne's, a private, K-12 Catholic school with 600 students.

"We chose the desiccant unit because the high levels of fresh air mandated by ASHRAE 62-89 necessitate pre-treatment of the outside air. Humidity levels are so high in the Southeast," says engineer Chuck Hammock of Andrews, Hammock and Powell in Macon, Ga., which designed the system. ASHRAE Standard 62-89, issued by the American Society of Heating, Refrigeration and Air Conditioning Engineers, sets minimum standards for ventilation air in buildings. It requires schools to provide 15 cfm of ventilation air per student. This large ventilation air

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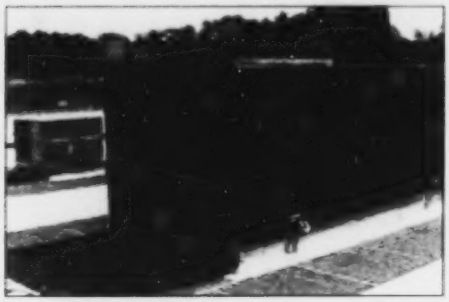
School Humidity/IAQ Control

Continued from page 1

requirement is especially troublesome in areas where outdoor air is highly humid.



The Munters HR20 desiccant dehumidification system supplies 5,000 cfm of fresh, dry air for St. Anne's classroom, library and computer building and helps the school meet ASHRAE Standard 62-89.

St. Anne's humidity control system features a Munters HR20 dehumidification system with heat recovery and a natural gas-regenerated desiccant wheel supplying approximately 5,000 cfm of dry air, according to Mike Hayes of Engineered Air Systems, which sells Munters equipment. Hayes says classrooms in the new wing are cooled by individual electric rooftop air conditioners. The desiccant system pre-treats outdoor air used for ventilation, removing moisture before it enters the air conditioners, enabling the air conditioners to operate more efficiently and economically.

Paul Dinnage, director of research, development and engineering for Munters, says that treating ventilation air using desiccant dehumidification reduces CO_2 and other air pollutants, while curtailing mold growth both in the building and within the air-handling units. In addition to promoting healthy conditions for students, it also protects school assets (such as books, computers and furnishings) from moisture-related deterioration.

Dinnage says Munters desiccant equipment is selling well in the Southeast because of two factors: the increase in new school construction to keep pace with population growth and the need to meet ASHRAE ventilation standards. "It is a very active market for us," Dinnage notes.

Hammock says moisture control is a big issue for schools in the region, and gas-powered desiccant systems are the answer. "We embraced that technology 2 to 3 years ago and decided to stick with it, because it is one of the simplest ways to actively remove the moisture from the incoming air stream and give us the consistent low relative humidity levels inside the building," Hammock says.

"There's definitely a demand for outside air pretreatment in Georgia, Florida, Alabama, and any location with high humidity levels through most of year," he says. "Columbus is in the southwestern quarter of Georgia, so humidity is a big concern."

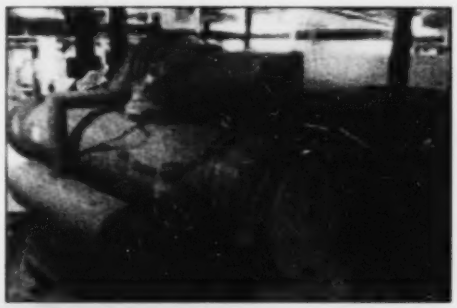
During a site visit this summer, Hammock measured relative humidity levels inside the building at 45%. This, he says, is "exceptional, considering it was a cooler, muggy day. In buildings without active humidity control systems, we typically observe relative humidity levels of 60% and sometimes higher in Georgia."

College Integrates Gas Engine Advantages Into Centrifugal Chiller System

When new chillers were needed at its West Campus to replace two increasingly inefficient 25-year-old single-stage low-pressure steam absorbers, Pima Community College in Tucson, Ariz., considered various options: direct-fired absorption, steam-fired absorption, gas engine-driven, and all-electric. The system the college chose was none of the above.

The Trane Company's successful response to the college's RFP featured two identical 900-ton Trane CenTraVac® direct-drive three-stage centrifugal chillers, one powered by electric from the grid and the other, by electricity produced in a dedicated Waukesha Enginator® a natural gas engine generator.

"We didn't at first consider a gas engine-driven genset. We had asked for a proposal based on ton-



Pima Community College, Tucson, Ariz., operates two identical 900-ton Trane CenTraVac® centrifugal chillers in an integrated system. For maximum savings, the all-electric chiller carries the base-load while the engine-driven chiller operates only during peaks.

nage and were expecting to see gas engine-driven equipment," explains Daryl Rawson, former superintendent of operations and manager for the Pima HVAC project (Rawson has since moved to the Tucson Unified School District to serve as utility manager). However, the system that Trane proposed perfectly met the college's criteria for two identical chillers, without the need to add costly electric capacity.

According to Rawson, identical chillers simplify maintenance. The maintenance staff only needs to train on one type of machine, and parts are interchangeable. "The primary advantage of the engine-driven CenTraVac® is its operation on less-expensive primary fuel during the June through October cooling season. In addition," Rawson points out, "if we reduce the frequency output on the generator by reducing the engine speed, we slow the chiller motor and increase its efficiency." It is not possible to vary the speed of the all-electric chiller to achieve more economical operation without the addition of an expensive variable frequency drive.

The electric CenTraVac® has been operating since summer 1998. The gas-driven CenTraVac® started up last May. Already, the college has a sense that there will be substantial fuel savings, as promised by the contractor.

"They like their new system," notes Bob Stofft of Southwest Gas. According to Stofft, it affords them fuel flexibility and gives them strength in negotiations with the utilities. "No one knows what's going to happen with fuel costs," Stofft continues. "With this system, the college is not putting all its eggs into a single basket. They can decide which fuel to use, depending on what gas or electric prices are at any time in the life of the equipment."

Rawson confirms that "Gas engine-driven equipment proved to be significantly more economical based on the way the college operates," using the engine-driven CenTraVac® to baseload and/or peak-shave based upon fuel prices at any given time. The college's goal, he says, is to hire an energy manager who will track daily and hourly fuel costs and apply energy management system software to select the most economical operating fuel.

In the off-months from November to April, the cooling tower works as a wetside economizer to provide cold water to air condition the core and perimeter of buildings, without use of the chillers.

The new chillers are installed in a newly renovated central plant, located in the basement of a three-story campus building. The cooling tower and the genset, connected to its dedicated CenTraVac® chiller through electric conductors, are situated in a support building 50 yards away from the central plant. Tunnels carry chilled water underground throughout the campus to serve seven large buildings that include classrooms, administrative offices and the student union.

Absorption Chillers: Perfect Fit for American Council on Education

The American Council on Education (ACE) started saving approximately $30,000 annually in utility costs 5 years ago when it began using natural gas cooling in addition to electric cooling in its offices at 1 Dupont Circle in Washington, D.C.

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Gas climate control equipment promotes healthy conditions for students and staff in a school's new wing located in humid Georgia.

Pima Community College, Tucson, Ariz. / Southwest Gas / Trane

Campus operates economically with identical centrifugal chillers: one powered by electricity from the grid; the other by electricity from a dedicated gas genset.

American Council on Education (ACE), Washington, D.C. / York

National educational organization documents savings with absorption chiller in an integrated gas/electric cooling system.

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Energy Concepts Unveils 8-Ton GAX Heat Pump with 0.87 COP

Trane's single-effect hot water and steam-fired absorption chiller line is targeted toward energy conservation applications.

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Cooling Center Speaks Out to a Power-Hungry Nation

AGCC Executive Director Tony Occhionero says America is ripe to hear about gas cooling in integrated systems.

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ACE Uses Gas/Electric Cooling *Continued from page 3*

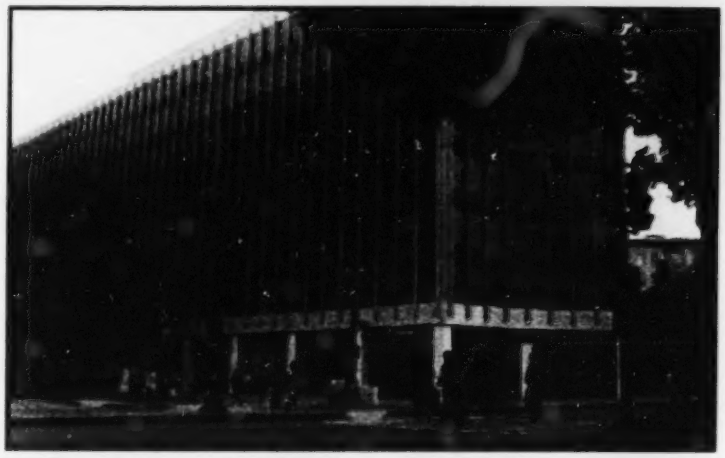
The eight-story office building, known as the National Center for Higher Education, is owned by ACE, a membership organization of 1,800 accredited degree-granting colleges and universities, according to council spokeswoman Laura Wilcox. Other occupants of the 190,000-sq.-ft. building include various higher education-related associations and The Aspen Institute, described by Wilcox as a "think tank." Now the education lobbyists, experts and thinkers can stay comfortable during Washington's well-known steamy summers while paying less for cooling.

The savings in electricity stem from installation in 1995 of a 300-ton York direct-fired double-effect gas-powered absorber along with two electric screw chillers, one providing 300 tons of cooling, the other 144 tons. This new equipment replaced 750 tons of electric chillers, according to Jeff Loeffler, chief engineer for ACE.

The old all-electric equipment was running well, he says, "but our efficiencies were down compared to any new type of equipment out there." In addition, he notes, ACE was deeply concerned with the impact that its old CFC-containing cooling equipment might have on the environment.

In 1994, Ross Murphy Finkelstein Inc., a Baltimore engineering firm, conducted a study on how best to renovate the building's chiller plant, while replacing it with new equipment of equal physical size. Based on its recommendations, ACE chose to install a high-efficiency absorption chiller/heater and two electric-driven chillers.

The organization received a $112,500 rebate from the regional gas utility to purchase the gas chiller, which uses water as its refrigerant. ACE also got help from the electric utility. "That made a big difference; it paid for about half the cost of the project," Loeffler says.



The American Council on Education saves $30,000 a year by switching from electric to gas cooling during peak-demand times.

The engineering study indicated that such an approach would save ACE $20,000 a year in cooling costs, but Loeffler says the amount is nearer $30,000 and could go higher if electricity costs escalate. In addition, Loeffler says, "With the old equipment, we used to have to run two pieces of equipment at the same time to cool the building, but now just one of the large air conditioning units will cool the building on the hottest day."

ACE began alternating the gas and electric cooling equipment, in an arrangement with PEPCO, the local electric utility, through which increases in the utility's kilowatt demand trigger a signal that notifies ACE to shut down its electric chillers and run only the gas-powered absorber.

"We cut down on kilowatt usage, which helps PEPCO with its peak load, and we get a rebate on any kilowatts we save on that day," Loeffler says.

Ken Kohr, a marketing engineer for York International in York, Pa., says absorption chillers are often used to shave electricity consumption during peak usage periods.

"Absorption chillers use energy sources (natural gas, oil or steam) that are in low demand during the summer months," Kohr says. "By using a combination of electric and gas-fired chillers in a cooling plant, commonly called hybrid cooling plants, consumers can force their energy suppliers to compete for their energy needs."

Another advantage of hybrid cooling plants is that the individual chillers are not operating constantly, according to Kohr. The units are taken on and off line based on the lowest energy costs, reducing the annual operational hours on each chiller.

Kohr says the United States has experienced tremendous economic growth, and electricity suppliers are having difficulty catching up to the power demand, resulting in blackouts, brownouts and increased electric prices throughout the nation.

"[Electric] prices go through the roof during summer. That's why natural gas is a perfect fit."

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GOP Enjoys Cool Comfort at Armory Events With Natural Gas in Integrated A/C System

Philadelphia's hot, old Armory was the scene of two big GOP bashes, July 30 and August 2. But revelers were cool and comfortable, thanks to an exemplary integrated gas/electric air conditioning system provided by America's natural gas industry, designed by the American Gas Cooling Center (AGCC), and shipped to Philadelphia for Republican National Convention festivities.

The 103rd Engineers Armory, an 84-year-old Pennsylvania National Guard facility, is not generally air-conditioned. When the GOP planned to use the 42,000-sq.-ft. site for two big bashes — Senate Majority Leader Trent Lott's American Bandstand, starring Dick Clark and featuring Bobby Vee, the Four Tops and the Shirelles, and the Texas Delegation's BBQ three days later — red flags went up. How can you keep 1,600 party-goers comfortable at typical mid-day, mid-summer temperatures?

In a cooperative effort that involved Munters Moisture Control Services (MCS) in addition to AGCC, the American Gas Association offered an answer by underwriting the cost for temporary air conditioning.

Engineers designed a model gas/electric integrated system that featured two 4,500 cfm Munters desiccant dehumidifiers, regenerated by natural gas. The system also included two generators to power two 90-ton electric DX air conditioners, and gas pipes and duct work. All equipment was standard and integrated to maximize fuel efficiency.

It took workers three days to install the system. TriState HVAC Equipment, West Conshohocken, Pa., laid a temporary gas pipeline; Ransome Engine, Bensalem, Pa., delivered the electric equipment; and two engineers from Munters MCS in Claymont, Del., integrated the system and installed 18-in. flexible duct-work to deliver the conditioned air into the building. Philadelphia Gas Works supplied the natural gas to fuel the system.

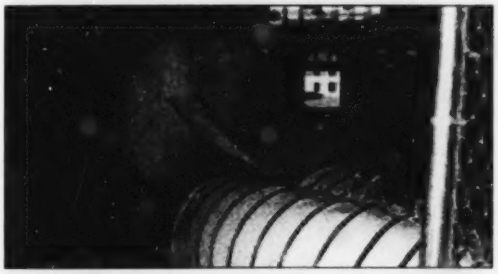
"The system worked beautifully," reports Bill Saulino, AGCC director of technology, who helped arrange the installation.

Larry Waltemire, regional manager for Munters MCS, explains that the armory's equipment delivered processed air containing only 25% relative humidity. "At this low humidity level, it is easier for the air conditioners to carry the cooling load and provide comfort at higher temperature settings of 75° to 80° F. That means that people stay comfortable while energy consumption is reduced."

According to Waltemire, "Desiccant dehumidification creates the ideal indoor climate because it helps control moisture and temperature separately." The dehumidifiers drew moisture from air passing through a wheel laden with desiccant material, which was constantly regenerated by heat from a gas burner. Conventional air conditioners successfully carried out the cooling process.

The Philadelphia Armory, built in 1916, was updated with a state-of-the art integrated A/C system, courtesy of the natural gas industry and AGCC, for two GOP events.

Robert Sullivan, northeast regional operations manager, Munters Moisture Control Services, links components of the model gas/electric integrated system. Two Munters natural gas-regenerated desiccant dehumidifiers (l.) pre-cooled and removed moisture from the air before it entered DX air conditioners (r.) on its way to the building.



Ed Mallory, northeast regional operations manager, Munters Moisture Control Services, connects ductwork that distributed cool, dry air throughout the building.

Bill Saulino (l.), AGCC director of technology, inspects the air conditioning system with Sullivan of Munters MCS.

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Energy Concepts Unveils 8-Ton GAX Heat Pump with 0.87 COP

Energy Concepts Co. announces the achievement of a new record level of performance in a heat-activated heat pump.

"An intense search has been underway over the past decade to achieve air conditioning and heat pumping with gas firing rather than electricity," says Donald C. Erickson, president, Energy Concepts Co. The search is motivated by the promise of a major increase in the energy efficiency of space conditioning and the need to reduce summer electric demand, which would benefit utilities and consumers.

Energy Concepts Co.'s patented "VX GAX" cycle has now achieved a gas-cooling efficiency (COP) of 0.87 in an eight-ton prototype. This performance is at air-cooled conditions: 41°F evaporator and 117°F condenser. In the heat-pumping mode, its gas-heating COP is 1.58, with delivered hot air temperature above 100°F. The heat pumping is effective down to sub-zero temperatures.

According to Erickson, the appliance will initially be available for light-commercial space-conditioning applications in the range of 5 to 50 tons. With average utility rates, its simple payback period is less than 4 years. Initial tests and evaluations will be conducted at user sites in 2001. A full slate of field demonstration tests is planned for 2002, with commercial introduction as early as 2003.

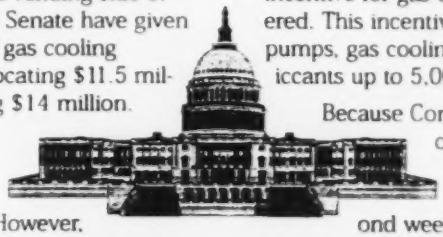
The development program for this equipment receives financial support from the U.S. Department of Energy HI-COOL program, administered by Oak Ridge National Laboratory for the Office of Building Technology. Control system development is assisted by the University of Maryland, Baltimore Campus (UMBC), with support from the Maryland Industrial Partnership System (MIPS). AGCC is providing marketing and field-testing assistance.

"The gas-fired embodiment of this appliance promises an appreciable reduction in nation-wide energy consumption and greenhouse gas emissions," says Erickson. "Long term, the greatest benefit will result from its ability to use low-temperature waste heat as well as gas firing. The eventual goal is to combine this appliance with a microturbine, fuel cell, or advanced reciprocating engine, to provide cooling, heating and electric power at exceptionally high efficiency."

For further information, contact: Don Erickson at: (410) -266-6521 or enerconcep@aol.com.

Federal Funding Update

September and early October are shaping up to be an interesting time for natural gas cooling and other end-use natural gas options. On the funding side of the ledger, both the House and the Senate have given their recommendations for natural gas cooling RD&D funding, with the House allocating $11.5 million and the Senate recommending $14 million.



When the two bodies meet in September to resolve their differences, natural gas cooling is expected to be fairly well funded. However, the bill that includes these monies will undoubtedly be vetoed by the President for a variety of reasons, and negotiations between the White House and Capitol Hill will ensue. There is an opportunity during this "reconciliation effort" for additional increases in RD&D dollars for gas cooling and buildings cooling, heating, and power (BCHP).

Additionally, there is some interest in including tax relief and incentives in the reconciliation package. Should taxes be an issue — and energy continues to be a national concern — it is possible that a tax incentive for gas cooling equipment will be considered. This incentive would be for gas-fired heat pumps, gas cooling under 20 tons, and gas-fired desiccants up to 5,000 cfm.

Because Congress is eager to concentrate on campaigning for the November elections, the members will likely conclude their business by the second week in October, which is when the status of the gas cooling R&D funding and tax incentives will be revealed.

In the meantime, AGCC continues to garner support both in Congress and with the Administration so that if new money does become available, AGCC is well positioned as a potential beneficiary.

If you have any questions about AGCC's federal advocacy efforts, please contact Jennifer Schafer at (202) 554-5828.

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Financing School Improvements

Continued from page 1

■ **Georgia** allows voters to approve 1% special purpose local option sales taxes (SPLOST), with revenue going to school building facilities improvements. Because Georgia voters frequently reject school capital bond issues, the state legislature began this initiative several years ago. Funds raised are used to build schools, but can also be allocated to road and jail construction.

"Voters like them [SPLOST] because they're not having to fund 100% of the cost," particularly in areas with a great deal of tourism, explains engineer Chuck Hammock of the Macon, Ga., firm Andrews, Hammock and Powell, which designs desiccant dehumidification systems for Georgia schools. "It provided an economic boost to the state through construction."

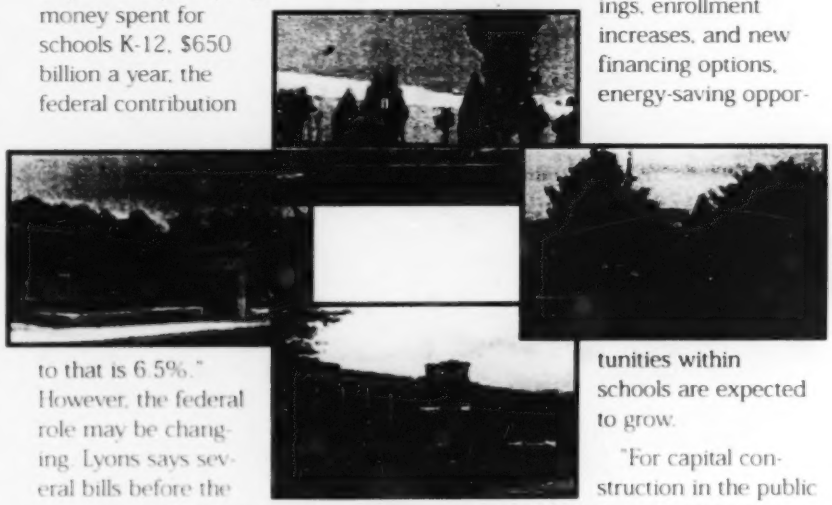
"If Congress passes a bill that allows for renovation plus new school development, there's going to be a huge market for renovating and building new schools, which will include new HVAC as a primary element."

-John Lyons, U.S. Department of Education

■ **New York State schools** are getting help from performance contracting by energy service companies known as ESCOs *(see related story, page 9)*. An ESCO is a business that develops, installs and finances projects to improve energy efficiency and maintenance costs for facilities, typically over a 7- to 10-year period. Among other tasks, ESCOs assume the risk that a project will save a guaranteed amount of energy. Funds already budgeted by the school district to pay for energy are instead allocated to repay loans for the equipment and installation. In some cases, contracts are set up so that a portion of the utility savings goes directly to the school district. After the loan is paid off, the energy cost savings go directly to the schools.

"This is an alternative way of schools implementing capital projects," says Robert Reifeiss, regional accounts manager with Central Hudson Enterprises Corp. (CHEC), a New York ESCO. "This is an ordinary contingent expense, which does not need the approval of the voters."

"Historically, culturally and constitutionally, schools are a local responsibility," says Lyons. "Of all money spent for schools K-12, $650 billion a year, the federal contribution to that is 6.5%." However, the federal role may be changing. Lyons says several bills before the U.S. House of Representatives and Senate would, if approved and signed by the president, provide $7.3 billion in funds in the form of interest-free bonds to support the renovation and development of new schools across the nation.



"We're pretty sure some parts of it will pass this year," Lyons says, noting one bipartisan bill has 250 co-sponsors. "If Congress passes a bill that allows for renovation plus new school development, there's going to be a huge market for renovating and building new schools, which will include new HVAC as a primary element. It is a golden opportunity [for the HVAC and building industries] in a lot of ways. The school population is increasing. It is expected to increase by another million [students] to 54 million by year 2008."

The National Association of Energy Service Companies (NAESCO) estimated in 1998 that more than $2 billion in energy improvements have been financed and installed in 4,000 K-12 schools nationwide through performance contracting, according to David Birr, a consultant for the association. Spurred on by dilapidated buildings, enrollment increases, and new financing options, energy-saving opportunities within schools are expected to grow.

"For capital construction in the public sector, ESCOs have become a creative financing solution," says Birr, who is president of Synchronous Energy Systems in Barrington, Ill. "You're taking the money you saved from your utility bill and using it to pay the cost of new capital improvements."

Ohio Study Analyzes School HVAC Systems

The findings of this massive Ohio school HVAC study could have far-reaching results. School districts across the United States will be able to use it as a guideline to select the most appropriate and cost-effective heating and cooling systems for their classroom buildings.

Over the next dozen years, Ohio will pump an expected $23 billion dollars into upgrading its public school buildings. To ensure that taxpayers get the most for this investment, the state is conducting a massive study comparing heating, ventilation and air-conditioning systems to determine which of many possible HVAC combinations delivers the lowest annual energy and life-cycle costs in schools.

"What we're trying to do is determine which is the best, most efficient, and why," says Stephen E. Petty, vice-president and senior engineer at Lawhon & Associates in Columbus, Ohio. The firm is conducting the study for the Ohio Department of Development's Office of Energy Efficiency, through support from the U.S. Department of Energy's Oak Ridge National Laboratories, the Ohio School Facilities Commission and the Geothermal Heat Pump Consortium Inc.

More than 80% complete, study results are due for release in early 2001. Its working title is "Energy and Cost Benefit Analyses of Heating, Ventilation and Air Conditioning Systems Available for Ohio Schools." Researchers are examining HVAC performance in two schools, a high school and an elementary school, that are being built within the guidelines of the *Ohio School Design Manual*. The 2-year-old manual, which sets criteria for school construction in Ohio, permits the use of 40 combinations of HVAC systems in educational facilities.

"We took the first two sets of blueprints for elementary and high schools and put all the elements into Carrier HAP [Hourly Analysis Program] code," says Petty, a research engineer. "We broke the high school into 99 zones, and the elementary school into 76 zones and moved them [on computer] into three cities, Columbus, Cleveland and Cincinnati. Those three cities reflect closely the extremes in climate and rate structures for Ohio."

Using the schools' architectural data, Petty is evaluating how well each of the 40 HVAC systems would perform if installed in a simulated identical school in each of the three cities. "We're looking at annual energy consumption – electric, natural gas and fuel oil – and the cost of energy," he says. "It's theoretical in some respects, but it's rooted in real buildings."

The study has six other goals: to look at enthalpy heat recovery, minimize electricity demand and cost, meet indoor air quality requirements, evaluate geothermal heat pumps, examine the use of daylighting, and compare life-cycle costs of HVAC equipment in addition to installation, operation and maintenance costs.

Daylighting is of considerable interest to state school officials, Petty says, because research indicates that students work better and get higher test scores in buildings with large amounts of natural light as opposed to artificial lighting. "We're looking at the energy implications of daylighting," Petty says, noting that putting more windows in a structure can increase the cost of cooling and heating. The study is examining two daylighting systems that a consultant determined were most likely to be used in Ohio schools.

"It's a huge study," Petty says, noting the team has compiled 17,000 pages of data. "It probably will have national implications once it's released." He adds that the real value to Ohio is that the study recommendations will likely be incorporated into the next version of the state's school design manual.

Few states have manuals like Ohio's that establish criteria for school design, according to Franklin Brown, a project administrator for the Ohio School Facilities Commission. Many states, including Michigan, Minnesota and Florida, have requested copies.

"Hopefully it will evolve into something the U.S. Department of Energy may make available on a nationwide basis," says William Manz, manager of the Ohio Department of Development's Office of Energy Efficiency commercial and industrial unit. "We are excited about the value of the results in effecting the construction of energy-efficient schools using the *Design Manual*. The study will provide the professional community valuable information about the life-cycle cost of each of the various HVAC systems."

The HVAC study will lead to better criteria for the manual, Brown says, noting the state mandated recently that all new schools built with state funds be 100% air-conditioned.

"What it's going to do for us is that it's the first time anybody has done a truly exhaustive analysis of all of the different options that are

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available for schools in Ohio," Brown says. "In the past, engineers had predominantly done systems they are familiar with. This allows them truly to make selections, decisions based on empirical facts."

The results of the study, he says, will help the state achieve energy efficiency in its schools while

- reducing the cost of operation;
- improving the quality of the environment; and
- providing good lighting and comfortable acoustics.

It will also make possible the selection of materials on the basis of life-cycle cost as opposed to initial cost.

He says the School Facilities Commission asked Petty to evaluate a locally produced heating system, look at geothermal heating and analyze the possibilities of microturbines for cogeneration. "We think it has significant promise," Brown says.

Brown maintains that interest in upgrading Ohio's schools is growing. "Our motive is that not too many years ago, it was determined by a federal study that Ohio was 48th in the nation in terms of facilities," Brown says. "We couldn't let that stand. I think we're running ahead of everybody at the moment."

Rick Savors, a legislative liaison for the School Facilities Commission, says Gov. Robert Taft has proposed a $23 billion, 12-year school rebuilding program that includes money from its $2.5 billion settlement with tobacco firms as well as state and local funding. The first 2 years' funds have been appropriated by the state legislature, he says.

For study details, Stephen Petty can be reached at (614) 975-4123 or spetty@columbus.rr.com.

School Cogeneration: A Growing Trend

Some schools in New York state are substantially cutting utility costs by using natural gas to generate electricity and recapturing heat rejected by the electric generator for cooling, heating, supplying hot water, and even warming indoor swimming pools. Small-scale cogeneration technology was developed a quarter-century ago for solar energy applications, and is finding new life at schools and other buildings in which recovered thermal energy is available for re-use.

"It's just a good way to save money and not pay it to the utility companies," says Robert Reifeiss of Central Hudson Enterprises Corp. (CHEC), a Poughkeepsie, N.Y. ESCO (energy service company) that has helped finance a number of modular cogeneration projects in New York schools. Reifeiss says savings vary depending on the school building and the local gas and electric rates.

Ballston Spa Schools Opt for Cogeneration w/ Heat Recovery

A combined high school and middle school in Ballston Spa, N.Y., is generating 60 to 70% of its own electricity and using heat recovered from the process to provide summer cooling, winter heating and domestic hot water.

"We can produce electricity at about a third of the cost of buying it from Niagara-Mohawk [a local gas and electric utility company]," says John Duffy, director of business and support services for the Ballston Spa School District.

Using money saved by reducing its utility bills, the school will add two additional 75kW gas-fired electric generators to its bank of 10 this fall. The new generators will increase the school's generating capacity by another 20%, according to Duffy.

"Cogeneration is capable of supplying 100% of a school's power needs."

Located 6 miles from Saratoga, N.Y., near the foothills of the Adirondack Mountains, Ballston Spa High School and Middle School serve 2,300 students. A few years ago the *Wall Street Journal* named Saratoga County, in which the school is located, one of the top 20 places to live in the United States, Duffy says.

The schools' cogeneration system was installed 2 years ago for economic reasons when a 245,000-sq.-ft. addition to the 100,000-sq.-ft. school complex was constructed. The older structure, which now houses the middle school, had no air conditioning and was heated with a trio of natural gas-fired boilers. Now a single utility plant serves both schools, and the gas boilers rarely operate unless the outside

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Through its exemplary cogeneration system, Ballston Spa High School saves more than $300,000 per year on utility costs.

School Cogeneration

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temperature drops below 10° F, according to Duffy.

The cogeneration units at Ballston Spa High School operate together, with 4 running at night and 8 or 9 during daytime hours. If one fails, the others stay in operation.

"They're using the waste heat [or thermal energy rejected by the generators] to provide about 95% of the heating for the entire school complex," says George Wilson, a branch manager for Custom Energy, the ESCO that financed the project. "They're also providing about 60% of the cooling, with the rest provided by a reciprocating centrifugal chiller."

The bulk of the cooling comes from a 160-ton single-effect Carrier absorption chiller that efficiently recaptures rejected heat in the form of hot water from the Tecogen generators, according to Mike Bronder, senior sales engineer with Carrier Corp. in Latham, N.Y.

Bronder says many school systems in New York state are looking at cogeneration and giving it consideration.

The Tecogen generators use a General Motors Corp. 454-cu-in. V8 marine engine modified to run on natural gas and linked to a 75kW electric generator.

"If people operate cogeneration properly and use the thermal energy [for cooling or heating], the overall efficiency approaches 90%," says Ray Hickey of R.L. Kistler Co., which sells Tecogen cogeneration equipment in upstate New York and Vermont. He says the system can generate electricity at a cost of approximately 7 cents per kWh, although it can go as low as 5 cents.

COGENERATION

Ballston Spa School:
Generates 60-70% of its own electricity and reclaims thermal energy from power generation to:

- drive a single-stage absorption chiller that provides 60% of its summer cooling;
- heat in winter; and]
- meet hot water needs (ie., for bathrooms, swimming pool).

Annual utility savings: more than $300,000.

"The real benefit of cogeneration is using the thermal energy byproduct," says Mark Infranco of KeySpan Energy Delivery, a utility company serving Long Island and parts of New York City. "If you're not using it [recovered thermal energy], cogeneration becomes less efficient. It supplements heat in winter, reduces the main boiler load, and in the summer it has [the] potential to cool."

Duffy says selecting all-electric air conditioning for Ballston Spa High School would have added significantly to the cost of the school addition. Nonetheless, cooling was needed, partly in the event that the district switches to year-round classes in the future.

The cogeneration system was installed at no cost to local taxpayers through a performance contract with Custom Energy, Wilson says. The $300,000 guaranteed annual savings on all utilities at Ballston Spa High School is being used to pay Custom Energy back over 10 years for its share of the $6 million project, for which the district also received state aid. An additional $70,000 in utility savings goes directly to the school district for instructional needs, although some will be used this fall to add two extra cogeneration units to the school.

Duffy says the school district loves cogeneration. "We've had very few problems, and our savings are exceeding what we had originally estimated," he says. "We've been under budget for the last 2 years in terms of electric and gas for those two buildings."

The Ballston Spa High School cogeneration project was listed as an exemplary new facility by *American School & University Magazine*, according to architect Marty Weber of Dodge Chamberlin Luzine Weber Assoc. in Rensselaer, N.Y. Weber says his firm is working on another cogeneration retrofit project that will completely remove Moriah High School in Port Henry, N.Y., from dependence on the power grid.

The indoor pool at Ballston Spa High School is heated by reclaiming extra heat from the gas generators that produce the school's electricity. The ability to reclaim excess thermal energy makes this cogeneration system highly efficient and an economic boon.

Ballston's bank of 10 gas-fired generators will increase to 12 this fall.

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Connetquot High School Halves Utility Costs

Another school, Connetquot High School in Oakdale, N.Y., is expected to save more than $220,000 a year, approximately half of its annual utility costs, after installing cogeneration equipment in two buildings on its Long Island campus, according to Mark Infranco of KeySpan Energy. "With electric rates among the highest in the nation, that's substantial energy dollars to be saved," he says. The savings are being used to repay the loan for the equipment and installation. The project was designed and constructed and is maintained by Central Hudson Enterprises Corp. (CHEC).

The cogeneration system at Connetquot was built by CHEC using Coast Intelligen cogeneration modules. These cogeneration modules use an 8-cylinder Ford engine that can be fired by natural gas or propane to drive a 60kW electric generator. Heat recovered from the cogeneration process, engine cooling jacket exhaust, and lubrication oil coolers is reclaimed through six hot water-fired 10-ton absorption chillers manufactured by Yazaki Energy Systems Inc. One chiller is used to dehumidify the school's indoor pool area, according to Bob Hochstein, director of plant and facilities for the Connetquot Central School District. Others cool the auditorium, main office and guidance rooms, and will soon air condition a computer room as well. The rest of the 1,500-pupil high school does not have air-conditioning.

"Basically we're operating the Yazaki chillers for free," Hochstein says.

"It's a great way to get free cooling," says Joe Wiche, a product support engineer for Yazaki, which also sells its equipment to Tecogen for school cogeneration systems. The Tecogen units heat water to 190° F for use in the Yazaki WFC-10 units, which each supply 10 tons of cooling. The cooling capacity of the unit is determined by the temperature of the hot water that is supplied to it. Hot water supply temperature can range from 167° to 212° F, he explains.

COGENERATION

Connetquot High School:
Generates its own electricity and reclaims thermal energy from power generation to:

- drive seven absorption chillers that air condition selected parts of the school; and
- meet hot water needs (ie., for the swimming pool).

Annual utility savings: more than $220,000.

The technology was originally developed for solar applications, Wiche says. It is receiving new interest because "people are getting more into integrated systems and looking into how best to use all of their utilities instead of letting heat go to waste," Wiche says.

Keith Anderson, the former director of plant and facilities at Connetquot Central School District, who is working on a similar cogen project in Patchogue, N.Y., says the performance contract with Central Hudson Enterprises included installation of energy-saving lighting at the high school. Other improvements included computerization of the building's temperature controls and replacement of its boilers with 12 Aerco gas fired modular steel boilers for heating.

"It's running very well," Anderson says, adding that cogeneration is saving more money than expected.

The school is a charter member of the U.S. Environmental Protection Agency's (EPA) Energy Star program.

EPA Administrator Carol Browner, in a June news release about Energy Star schools, praises efforts to make schools more energy-efficient. "Every year, the annual energy bill for the nation's 115,000 primary and secondary schools is approximately $6 billion — more than schools spend on computers and textbooks combined. Energy-efficient schools can not only save millions of dollars, but also help protect the health and environment of all Americans by reducing pollution that contributes to global warming," says Browner.

The cogeneration system at Connecquot High School was installed at no cost to local taxpayers through a performance contract with an ESCO.

Connetquot High School's indoor pool is heated through cogeneration.

"It's a good thermal fit," Infranco says, adding that nearby Hauppage High School is looking into cogeneration partly as a way to save the annual cost of 20,000 gallons of fuel oil to heat its indoor swimming pool.

Other Northeastern Schools Catch On to Cogen

LaSalle Military Academy in Oakdale was the first on Long Island to experiment with cogeneration in 1992, although small-scale cogeneration technology has been available for at least a quarter-century, according to Infranco.

So far, only 12 of Long Island's 800 or so public schools have installed cogenerating equipment, but other school districts are taking notice.

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School Cogeneration

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"It's very attractive to the schools because there is no out-of-pocket expense. They don't have to go to the public for voter approval," says Infranco. School districts finance the cogeneration equipment through loans, usually 10 years in duration, arranged by ESCOs such as Central Hudson or KeySpan Business Solutions.

"Every year, the annual energy bill for the nation's 115,000 primary and secondary schools is approximately $6 billion – more than schools spend on computers and textbooks combined. Energy-efficient schools can ... save millions of dollars ... [and] help protect the health and environment of all Americans."

-Carol Browner,
U.S. Environmental Protection Agency Administrator

The schools' energy savings are structured into the loan, so there is zero financial impact on the school. After the loan is paid off, schools reap the windfall from lower utility bills. Some agreements give the schools a portion of the utility savings immediately but require a longer loan payback period.

The systems being used in Long Island schools are capable of generating 20 to 25% of a school's total electric requirement. This can represent a significant amount of money for taxpayers on Long Island, where utility bills are among the highest in the nation.

"They're definitely saving on the electric side," Infranco says, pointing out that a school on Long Island may be paying as much as 11 cents per kWh for electricity. Cogenerating electricity costs approximately 4 to 5 cents per kWh, not counting the savings realized by reclaiming the hot water byproduct of the process.

Other New York State school districts using cogeneration include Poughkeepsie, Deer Park, Hicksville, Smithtown, Syracuse, Clinton, and the Madison-Oneida district's vocational school, all of which were designed, constructed and operated by Central Hudson Enterprises.

In upstate New York, Rosetti Vocational Center in Verona is generating 62% of its own electricity using a Tecogen system. However, not all schools can realize savings from cogeneration, Infranco cautions. Smaller schools such as elementary buildings may not have load requirements large enough for cogeneration to be worth the cost.

Jeff Glick of Tecogen says his company is installing 30 cogeneration systems and chillers in schools in upstate New York. He attributes much of the heightened interest in cogeneration to a competitor, microturbine technology.

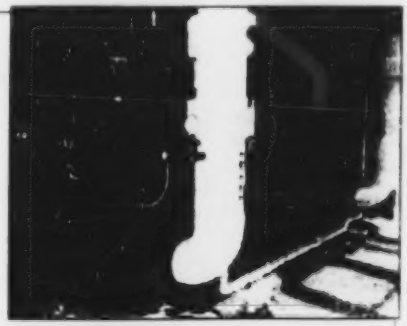
"These new microturbines on the market are bringing a lot of interest," Glick says. "It's boosting public awareness of cogen."

Wilson says cogeneration is a growing trend in technology. "It's much more efficient, environmentally much cleaner burning," he says. "You use waste heat instead of dumping it." Added benefits include lower-emission power – not electricity generated by burning coal – and higher-quality power, with fewer risks of service interruptions that can damage computer equipment. In a few instances in which schools are making electricity independent of the power grid, they can serve as emergency centers when communities lose electric service.

That happened during a severe ice storm and power blackout in

FOR THE RECORD

A pair of 65 ton air-cooled TECOCHILL™ chillers by **Tecogen** was installed this summer at **Mississippi Valley Gas Co.** in Jackson, Miss. Two similar models were set up on a flatbed trailer at nearby **Columbus (Miss.) Air Force Base** to provide emergency cooling in the barracks. Tecogen also installed three 65-ton air-cooled chillers at **Jack Britt High School** near Fayetteville, N.C. . . . UGI reports the installation of **Munters** humidity control equipment, with desiccant regenerated by natural gas. The new 1 million-sq.-ft. **Hershey Foods Distribution Warehouse**, Hershey, Pa., installed two 10,000-cfm units. **Schmalbach-Lubeca**, a German firm that has opened a new plastic injection molding operation in Allentown, Pa., has installed two 4,000 cfm units there. . . . **Florida Public Utilities** installed a **Robur** 25-ton GAX Chiller Link℠ at its Corporate Office in West Palm Beach last November. "It's running pretty well," according to Winston Humphrey, the utility's market applications engineer. The Robur GAX replaced an aging engine-driven system.



Tecogen has installed one 150-ton water-cooled TECOCHILL™ chiller at Columbus (Ga.) State University.

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Plattsburgh, N.Y., when several schools with independent cogeneration systems functioned as emergency crisis centers, according to Wilson.

Is Supplying Power to Utilities Next?

Purchasing equipment that makes a school's cogeneration system independent of utility-supplied power is more costly. Even so, "There are actually school districts in New York that are going off the grid," Wilson says, naming Port Henry, Fonda-Fultonville and Byron-Bergen schools as examples.

"We're in the process of negotiating with the Public Service Commission in New York to let schools wheel their excess power back to the grid," Wilson says. Such a move, he contends, would make sense, given problems with power transmission in the state.

Noting that the Northeast's electrical grid is stressed in June, July and August, and that schools with cogeneration systems have excess generating capacity during those months, Wilson says selling school-generated electric power back to power companies offers many benefits.

"Two weeks ago the *New York Times* had a front page article about state power transmission problems," Wilson says. "New York doesn't have the generating capacity or transmission capacity it needs. We've got 24 school buildings in the state [with cogeneration systems], and if we had a mechanism to put their excess power back in the grid, it could substantially impact the state."

Selling excess electric power could also supply much-needed income for school districts, according to Wilson. "There are school districts in Pennsylvania that get paid money just to have the option [of supplying power to the utilities] available," Wilson says. "A Pittsburgh utility company might pay a school $15,000 to $30,000 to have power available in case of need."

Wilson says Custom Energy is in the process of installing cogeneration systems in five schools in the Vernon Township, N.J., school district through a $6 million performance contract.

Cogeneration is capable of supplying 100% of a school's power needs, according to Hickey. But he says the New York State Department of Education has thus far frowned on the practice, contending schools are in the business of education, not power generation. Hickey adds that in some cases New York communities have voted to generate power in their schools, and subsequently obtained state permission to do so. He says outlying areas that have power distribution problems because of their distance from electric transmission centers are prime candidates for cogeneration technology.

The School IAQ Dilemma: Sources & Solutions

Why can't Fletcher read or concentrate? Why is Felicia always sick? It could be that the air quality inside their schools is affecting children's ability to learn and even to stay healthy.

Causes and Effects of Poor IAQ

Mold and mildew, volatile organic compounds, and an array of other indoor contaminants are all prime suspects in lowering academic performance and increasing health problems among school children. The rapid growth in asthma cases, high absenteeism and frequency of colds among children age 10 and younger may be linked to inadequate indoor air quality (IAQ) in schools, some studies are finding. Drowsiness, headaches and poor concentration may stem from the same cause in many cases.

"Fifty percent of schools in the United States have air conditioning, heating, roof, or water incursion problems... Way more than 20% have IAQ problems."

-James Woods,
HP Woods Institute

Teachers also suffer from the effects of poor school air quality, with reduced productivity and increased absenteeism, although research indicates growing children are far more susceptible than adults to the effects of pollution.

Studies by the U.S. Environmental Protection Agency show that indoor levels of pollutants may be 2 to 5 times, and sometimes more than 100 times, higher than outdoor levels, according to the federal agency's IAQ Tools for Schools Web site at http://www.epa.gov/iaq/schools/scholkit.html.

In addition, several recent studies are cited by Charlene Bayer, Sidney A. Crow and John A. Fischer in *Causes of Indoor Air Quality Problems in Schools*, a summary of scientific research prepared for the Energy Division at Oak Ridge National Laboratory. These results highlight the importance of achieving acceptable IAQ in schools.

Physiological and Health Effects

A 1998 study of 39 British Columbia schools found that 71%

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School IAQ

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failed to meet ASHRAE Standard 62-89 ventilation requirements, while 45% of the classrooms had average CO_2 concentrations greater than 1,000 ppm. High levels of CO_2, which indicate inadequate ventilation, can cause significant physiological effects including fatigue, drowsiness, lack of concentration, and a sense of breathing difficulty, according to a 1992 study by Armstrong Laboratory.

The British Columbia study also indicated that the highest predictor for bacterial concentration is indoor CO_2 concentration. In addition, the authors found that inefficient ventilation and low relative humidity, particularly during the winter, may spread airborne infectious diseases.

Schools with desiccant systems have better indoor air quality than those without.

-According to Georgia Tech Research Institute data

John C. Brady, P.E., an engineer with Unicom Energy Solutions in Minnesota, who has designed humidity-control systems for schools in his home state, says health issues stemming from heavy mold growth have forced the closing of some Minnesota schools. The extreme dewpoints that can lead to mold overgrowth are a particular problem along the Mississippi River valley in Minnesota and points south, as well as in states in the southeastern United States and along the Eastern seaboard and Gulf Coast, according to Brady. In these areas, he says, mold-related illnesses in schools can be a serious problem.

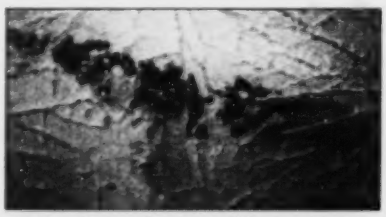
"It's so out of control that it's going to make the asbestos problem look like a cakewalk," Brady says.

Costs of Meeting ASHRAE 62-89

In 1996, John Fischer, technology consultant for SEMCO in Columbia, Mo., released a study on the costs to accommodate ASHRAE Standard 62-89 ventilation standards and control indoor relative humidity between 30% and 60%. The study showed compliance costs ranged from $62 to $205 per student, and averaged $95 for a single-wheel total energy recovery system approach; $142 for the dual-wheel desiccant-based total energy recovery system. This cost increase is compared to the cost of a conventional system providing only 5 cfm per student of outdoor air and not controlling space humidity. Fischer found that the cost of meeting the ASHRAE 62-89 standard in a school with conventional equipment was on par with the more energy efficient, total energy recovery system approach.

He concluded that cost savings and cost avoidance, linked with benefits of a desirable IAQ, justify the additional expense. These projected benefits include improved learning as well as reductions in absenteeism, hiring of substitute teachers, and health care costs, improved filtration efficiency, and reduced filter maintenance.

Schools in the study that experienced IAQ problems due to inadequate ventilation and humidity control all had to spend far more on remediation, legal expenses and renovation costs than it would have cost to design, construct and operate their buildings to meet ASHRAE guidelines in the first place.



This photo shows mold growing on a school's ceiling, as documented by the Georgia Tech Research Institute.

IAQ Measured in Georgia Schools

"I think it's quite clear that most schools do not supply enough fresh air ventilation, and given that, the IAQ in schools tends to be sub-par. If you do pull in enough outdoor air for ventilation, you need a good dehumidification system," says James Sand, Ph.D., research engineer at the U.S. Department of Energy's (DOE) Oak Ridge National Laboratory in Tennessee, who has been monitoring an air quality research project in 10 Georgia schools.

In this 1999 DOE-funded study, five schools with either SEMCO or Fresh Air Solutions desiccant humidity control systems were matched with five that had no humidity control systems. Levels of relative humidity, temperature and CO_2 were monitored continuously for a year. The schools were also tested several times during the year for airborne microbes, volatile organic compounds, particles, aldehydes, and ketones. None of the schools had known IAQ problems.

While some data from the study is still being analyzed, principal researcher Charlene Bayer, Ph.D., of the Georgia Tech Research Institute found that schools with desiccant systems, in general, had better indoor air quality than those without.

"The desiccant systems were delivering as much as 3 times more outside air while maintaining the indoor relative humidity at the

same or better percentage than conventional systems," Bayer writes in this summer's issue of *IAQ Applications*, which is published by the American Society for Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE). "Higher outdoor air delivered to the indoor spaces of the schools lowered pollutant levels."

DOE's study recommended research into the following areas:

- learn the degree to which IAQ problems in schools increase asthma, sick building syndrome symptoms and absenteeism;
- identify various factors that impact indoor environments;
- determine whether improved IAQ can foster learning;
- determine the cost-effectiveness of remedying IAQ problems in schools; and
- determine the cost of lax or inadequate building maintenance with respect to students' health and learning.

Sand says adequate ventilation can solve the majority of IAQ problems. "I think if we solve 80 to 90%, and the outdoor air is [made] dry enough with air conditioning or desiccant systems, most IAQ problems in these schools will disappear."

Bayer notes that indoor air that is too dry can also result in health problems.

"We want to maintain an indoor RH [relative humidity] of approximately 50% and provide continuous ventilation to the spaces," she says.

The Solution? Control Humidity and Add Fresh Air

Attention has focused on environmental factors affecting student performance since the U.S. General Accounting Office released a study in 1996 stating that one in five schools in the nation has IAQ problems. Some experts believe the number of affected schools is even higher.

"Fifty percent of schools in the United States have air conditioning, heating, roof, or water incursion problems," says James Woods of the HP Woods Institute in Herndon, Va., which studies the interrelationship between health science and building science.

"These deficiencies in [building] performance are partly because some are old, [and] partly because of lack of maintenance. Way more than 20% of schools in the United States have IAQ problems," Woods says, adding that the GAO report found 13% of all U.S. schools reported five or more unsatisfactory environmental conditions.

"It's consistent with evidence that I see in buildings all the time. We've reported for almost 15 years now that 20 to 30% of all buildings in the United States and Western Europe have problems that are sufficient to cause symptoms of sick building syndrome or building-related illness," he says.

The average age of U.S. schools is 42 years, and years of deferred maintenance are having their impact on students. But until recently, school facility problems have been largely neglected.

"Children don't vote," says William Turner, president of Turner Building Science LLC in Harrison, Maine. He blames water intrusion for many air quality problems plaguing schools. "One of the biggest problems is allowing the indoor air to hit dewpoint, causing condensation on cold surfaces, and dehumidification is the only logical way to take care of that," Turner says. "Any time you are close to dewpoint in the air, you will grow mold on cold surfaces."

The gas cooling industry offers a variety of economical solutions that can help clear the air and improve the learning environment for Fletcher, Felicia and their teachers. Front and center, there are gas-fired desiccant moisture control systems to remove humidity that facilitates mold growth, as they bring in enough ventilation air to lower concentrations of volatile organic compounds and CO_2 to acceptable levels.

The 13 Minnesota schools will be cooled and dehumidified using a fusion of engine-driven chillers, natural gas desiccants and thermal displacement ventilation technology.

Minnesota Schools Fight IAQ Problems with Innovation

Thirteen schools in an eastern Minnesota community outside Minneapolis-St. Paul are getting innovative new HVAC systems designed to address humidity and resulting indoor air quality (IAQ) problems in their buildings.

Pike Lake Elementary School is the first of the Mounds View Independent School District buildings under construction. The school was closed for several months three years ago after a mold problem was discovered inside the building. It was remediated and reopened, then closed again for extensive renovations that will include the addition of air conditioning. The project is expected to be completed in 2001.

"They just had unit ventilators with no cooling," says Brent Jones,

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School IAQ Innovations

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a project development manager for Johnson Controls in Minneapolis, which is involved in value-engineering and managing the project. "We're giving them humidity control and drastically increasing their ventilation rates."

The schools will be cooled and dehumidified using a combination of engine-driven chillers, desiccants and thermal displacement ventilation technology as the result of a collaboration between two engineering firms, Dunham Associates and Armstrong Torseth Skold & Rydeen Inc. (ATS&R). The firms worked together on design standards for the district-wide project, which will affect eight elementary schools, three middle schools and two high schools and which will include other building improvements in addition to the mechanical systems.

"This is the first we know of, using both systems combined," says architect David Paeper of the firm of Perkins & Will. "ATS&R was designing desiccants while Dunham was designing displacement ventilation. We got the two engineers together and they realized there were a lot of synergies. If they combined the two technologies they'd have a much better indoor air quality solution than doing each [technology] alone. The two engineering firms actually cross trained each other."

Displacement ventilation, which is commonly used in Europe, involves supplying cool fresh air into rooms from the floor level and removing it through ceiling vents. During its movement through the room, the cool air is warmed by the "thermal plume" or body warmth of the occupants, causing the air to rise along with indoor contaminants it may contain.

DesChamps Laboratories Inc. of Natural Bridge Station, Va., is supplying the desiccant system for Pike Lake E.S. while the Halton Company of Scottsville, Ky. is manufacturing the thermal displacement diffusers. The remaining equipment bids have not been awarded.

Displacement diffusers, each 3- to 6-ft. tall, bring in the conditioned air. The air velocity leaving the diffusers is very low, so most room occupants don't even realize they're operating, says Matt Keck of Dunham Associates. Such a system is beneficial for a classroom, because it produces very little noise and there is no blast of cold air.

"One of the big benefits is that heat sources in a room are typically the contaminants -- water vapor, dander, CO_2, body odor," Keck says. "The vast majority of contaminants are carried away through thermal displacement. There have been studies in Europe and they've found it to be 2 to 8 times better in terms of air quality than a conventional mixing system, depending on the study."

In addition to thermal displacement ventilation, the schools will install engine-driven chillers and desiccant dehumidification equipment. Natural gas-fired boilers and heat recovered from the chiller will be used to regenerate the desiccants.

The schools, built in the 1950s and 1960s, have unit ventilators in individual classrooms.

"These ventilators are not the optimum solution when you consider the whole matrix of energy efficiency, maintenance and indoor air quality," Keck says. He adds that air quality is of particular concern where children are involved.

"Their immune systems are still developing so they don't have the defense mechanisms yet. Also, they breathe and take in a higher percentage of the pollutants in the air. Their bodies bear a heavier burden of the pollutants in the space," Keck says, noting that the school district was concerned with properly addressing the air quality issues.

"The primary reason the school district chose the desiccant dehumidification option is because it prevents condensation on the cooling coils, reducing the possibility of mold growth and bacteria on the cooling coils," Keck says. "If you have mold growing in your drain pan, the mold is releasing toxins into the air. You have to take a holistic approach to IAQ, look at everything from the outdoor air, to how you're conditioning the air, to how you're delivering the air through your system."

Paeper says Minnesota has moisture control issues.

"There's a lot of water in the state," he notes. "It's the land of 10,000 lakes."

According to Paeper the school district reacted quickly to complaints about mold at Pike Lake E.S. three years ago, shutting the school and temporarily shifting pupils and staff to temporary facilities. After several months of remediation work to encapsulate or remove affected areas, the school was reopened. In the meantime, a community IAQ committee was formed to look into improving air quality in the entire school system. The result of the study was a proposal to finance improvements through a bond issue, approved by voters in May 1999.

Jones says the unique combination of technology will provide the school system with the lowest available life-cycle costs.

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SCHOOL IAQ RESOURCES

In August, EPA announced an incentives program to promote use of its IAQ Tools for Schools kit.

Components include:

- an outreach campaign that focuses on the importance of good school IAQ and its connection to student performance;
- mentoring efforts;
- innovative technical tools;
- awards and recognition for leaders in promoting school environmental issues; and
- private-sector partnering by corporations and businesses to provide technical assistance for schools using the IAQ kit.

For ordering information, go to http://www.epa.gov/iaq/schools/schoolkit.html. The Web site is co-sponsored by the National PTA, National Education Association, the Council for American Private Education, Association of School Business Officials, American Federation of Teachers, and the American Lung Association.

The National Clearinghouse on Building Facilities (NCBF) offers information on school IAQ issues on its Web site at www.edfacilities.org.

Another Web site, www.itvisus.com/techno.htm.producer, includes information about a video produced by the NCBF called "Designing Smarter Schools." The video was broadcast June 4 on CNBC and will be shown again several more times this year according, to Judy Marks of the Clearinghouse.

"The proposed systems' utility costs will be 55% less than systems designed around the Minnesota state energy code and using traditional electric cooling," adds Jones. He says the cost savings figure was obtained through an analysis conducted by the Weidt Group, an energy consultant. Weidt used a U.S. Department of Energy building simulation program that evaluated the cost of installing traditional HVAC equipment in Pike Lake E.S. based on Minnesota's energy code, compared to installing the gas engine-driven chiller, desiccant dehumidification and thermal displacement ventilation.

The school district is using bond money, a state health and safety levy and alternative facility bonding to finance the project, Jones says.

CJ Córdova Joins the Cooling Center

Cynthia "CJ" Córdova has joined the Cooling Center as managing director. Formerly the American Gas Association's vice president of market development, CJ brings a breadth of experience to the task of commercializing gas cooling/heating, refrigeration and humidity control technologies in integrated systems. CJ can be reached at: (202) 824-7142; ccordova@agcc.org.

NEW MEMBERS

AirXchange • Armstrong International
Nortec Industries • Trigen Energy

Munters: Drying, Guaranteed!

Based on experience gathered during 20,000 water damage recovery projects, Munters Moisture Control Services has published new drying standards for drywall, hardwood floors, documents, and cementitious materials. The new standards will be used by Munters as the company's new "Five Point Guarantee" on all future drying projects.

Copies of the complete standards are available by contacting any Munters MCS professional or calling **800-Munters**. This new toll-free number has been established to serve customers of all of Munters' North American divisions, including the DH Division (Cargocaire and DryCool).

Dereg Opportunities for Texans

Electric utility deregulation in Texas is bringing with it new energy efficiency opportunities for customers and the energy services community.

Under the Texas restructuring plan, which takes effect in 2002, electric utilities will administer new energy efficiency incentive programs for all market segments. These programs, which will be implemented primarily by energy service companies (ESCOs) and retail electric providers (REPs), cover fuel switching (from electric to gas), including gas cooling, under certain circumstances.

The state's largest utility, TXU, has just completed a pilot program for the large commercial and industrial retrofit market. Additional pilot programs will be unveiled throughout the transition period leading up to the onset of competition in January 2002, according to TXU Commercial Market Manager Greg Anderson.

For Holistic Cooling System Attention

Bon Aqua International Inc., a Greensboro, N.C., firm, sells water treatment systems that can keep boilers and cooling towers from developing scale and corrosion without the use of chemicals. The Bon Aqua systems protect pipe interiors by inducing a focused magnetic field. The Faraday's generator creates an environment in which it is physically impossible for corrosion, pitting and scaling to occur.

Gerald H. Lowenstein, chief executive officer of Bon Aqua International, says use of the product yields significant water and energy savings, results in less downtime for equipment repair and maintenance, and leads to environmental compliance by eliminating the need for chemicals to remove scale.

Additional information is available through the company's Web site, www.bonaqua.com or by calling its toll-free number, (888) 294-2424.

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Cooling Center Speaks Out to a Power-Hungry Nation

By Tony Occhionero
Executive Director
American Gas Cooling Center

All summer long, Americans experienced power outages. California was hit the hardest. With record heat, San Francisco businesses on interruptible electric rates had their power cut for a couple of days in early summer. The same thing happened during a subsequent heat wave around Los Angeles.

The LA situation could have been much worse. If Mother Nature hadn't turned off the triple-digit temperatures on the third day, the area could have faced its worst power catastrophe ever. With electricity reserves at an all-time low – near 5% of capacity – high demand on that third day could have crushed the grid. If that had happened, not only would interruptible customers have been affected, the total system would have collapsed. Everyone in the region would have been left in the dark.

U.S. Secretary of Energy Bill Richardson says that blackouts are to be expected. The U.S. power grid is sorely stretched by ever-increasing demand for electricity. Yet new power plants are not being built and new, modern transmission lines are not being added. Outages will become more and more commonplace, because of periodic shortfalls between supply and demand. This precarious state of affairs is exacerbated by heat waves and high demand, especially demand for electric air conditioning.

With public awareness heightened by these power outages and media discussion focused on the crisis looming over the electric grid, the Cooling Center took the opportunity this summer to promote gas cooling as a remedy. We delivered our position in plain English. For the first time, both trade and popular press gave us coverage, with *USA Today* carrying our "Letter to the Editor" on August 11, a Friday, when its circulation peaks *(see text, right)*.

Whenever we anticipate an occasion to promote gas cooling to consumers, the Cooling Center will seize that opportunity to show that we have equipment ready to meet America's needs for highly efficient and economical air conditioning that can help to prop up the fragile electric grid.

We anticipate taking a similar approach to the press as the school year begins. As parents, educators and school administrators encounter indoor air quality (IAQ) problems and high air conditioning bills, we will speak out on how gas cooling technologies are available to address those issues.

Please join your voice to ours. Let your local communications outlets know that gas cooling is a technology that consumers should embrace because it offers many benefits. Integrated into systems with electric equipment, gas cooling can shave peak demand and help to free up capacity on the electric grid.

One installation can't solve the problem, but if we encourage the installation of one system after another, so that 10% of each year's new installations run on natural gas instead of electric, we'll have overcome America's electric shortfalls.

USA TODAY

Our Letter to the Editor appeared in the Friday, August 11 edition of USA Today, in answer to the paper's August 2 lead story about California's growing electric crisis:

"What about solutions?"

USA TODAY does an excellent job researching the scope of the crisis looming regarding the U.S. power grid. But the report leaves readers facing the threat of persistent blackouts without offering solutions.

Americans need to know that ready solutions exist.

Air conditioning consumes 40% of our electricity. During heat waves, increased electric demand created by air conditioning causes the fragile power grid in California and elsewhere to crash. We can keep the grid in operation by entreating consumers to adopt alternative fuels, including natural gas, to power air conditioning. Businesses that integrate gas cooling into existing electric air-conditioning systems can continue to operate during heat waves. In addition, they are able to displace enough kilowatt demand to secure the electric grid for others.

Specifically, if 3,000 Wal-Mart-size facilities switch half their air conditioning load to natural-gas-driven chillers and integrate it with electric equipment, they will displace 1,000 megawatts of electricity – enough to keep 800,000 homes online whatever the weather.

Gas cooling technologies are available today from leading U.S. manufacturers. Integrated gas-electric systems operate successfully, efficiently and economically as alternatives to all-electric plants. Installing more of these innovative systems would ease the strain on the electric grid.

Tony Occhionero
Executive Director
American Gas Cooling Center
Washington, DC

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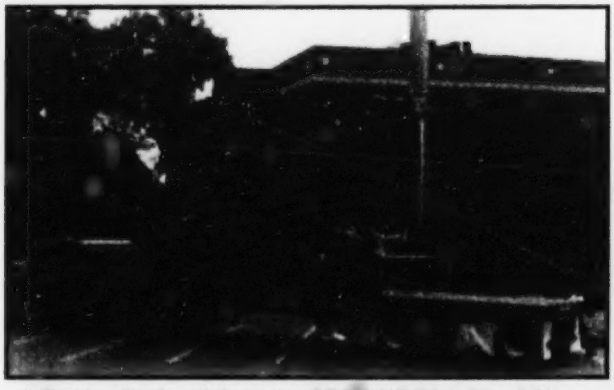
Progress Continues at BCHP Demo Site: Desiccant Unit Installed, Controller Refined

Progress continues at the Chesapeake Building, the Buildings Cooling, Heating, and Power (BCHP) research and demonstration site at the University of Maryland (see July/August 2000 *Cool Times*). This installation of an advanced air conditioning system was undertaken in a typical office building in cooperation with the U.S. Department of Energy (DOE), Oak Ridge National Laboratory, and industry partners, to achieve 30% higher energy efficiency with 45% lower CO_2 emissions. The demonstration is expected to show:

- integration of readily available BCHP technologies;
- operating cost savings;
- improved indoor air quality through humidity control; and
- true initial and operating costs of BCHP technologies.



A DryHandler® unit from the DESICAiR Division of Air Technology Systems Inc., arrived on site in July and was installed at the Chesapeake Building, the BCHP demonstration site at the University of Maryland.

The building has two zones with similar cooling loads and identical 90-ton standard Trane DX rooftop units. Each zone is being equipped with a BCHP system.

In the first BCHP system, two 20-ton engine-driven Goettl units were made fully operational by balancing the charge, superheat, and air discharge temperatures of the refrigeration system, and optimizing the engine speed and throttle for the rated operation. Capron Company, which provides controls for the demonstration, integrated the Goettl units to produce four stages of cooling before the Trane DX unit is energized. The DryHandler® unit from the DESICAiR Division of Air Technology Systems Inc. (ATS) arrived in late July and will be fully integrated by the end of September. As the BCHP team installed the extensive instrumentation to characterize performance of the ATS unit, it became apparent that more advanced controls are needed to enable the Goettl, ATS and Trane equipment to provide feedback to the Capron controls for maximized integration and performance. A new Internet-based controller was obtained that has the ability to communicate with different open communication protocols, such as the Capron controller's ModBus protocol and the ATS controller's N2 Bus protocol. The new controller provides an innovative control platform, an important step toward desired integration of the BCHP equipment.

In the second BCHP system, the BCHP team has run the Honeywell microturbine to produce preliminary performance data and gain familiarity with its operation and controls. Broad engineers are testing several prototypes of their 60-ton absorption chiller to find the correct match to maximize the utilization of thermal energy from the microturbine's exhaust gases. The Broad chiller is expected to be delivered in March 2001 for the next cooling season. Honeywell and the BCHP team have also been working to design Honeywell controls for this system.

Cool Times will continue to follow the progress of equipment installations and research at the Chesapeake Building, and report outcomes as they become available.

For further information about the BCHP research and demonstration project and possible cooperation, contact Predrag Popovic, Ph.D., faculty research associate, Center for Environmental Energy Engineering, Dept. of Mechanical Engineering, University of Maryland: (301) 403-4410 or popovicp@eng.umd.edu; or check the Web page: www.enme.umd.edu/ceee/bchp/.

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